11/13/2009

Mobile and Portable Device

RF Exposure Procedures and Equipment Authorization Policies

This document identifies certain RF exposure evaluation procedures and requirements and equipment authorization policies for mobile and portable devices.[1] It replaces preceding versions of this KDB and should be used in conjunction with other FCC policy and procedure documents.[2] Unless otherwise specified, the power thresholds in this document are applied for conducted output power with respect to source-based time-averaging defined in §§ 2.1091(d)(2) and 2.1093(d)(5) of the rules. While certain simultaneous transmission issues have been addressed in *specific FCC test procedures*, RF exposure evaluation considerations for other product configurations are still necessary.[3] As products and technologies continue to emerge, the FCC Laboratory should be contacted using the OET-Lab Knowledge Database (www.fcc.gov/labhelp) about additional procedures and specific test requirements.

1) General test requirements and specific FCC test procedures

a) When required, portable devices must be evaluated using the *specific FCC test procedures*, and the SAR measurement techniques of OET Bulletin 65 Supplement C 01-01 and IEEE Std 1528-2003.

b) When routine evaluation is required for SAR and the output power is $\leq 60/f_{(GHz)}$ mW, the test reduction and test exclusion procedures given herein, or in KDB 616217 and its supplement or KDB 648474, are applicable.[4]

c) Unless excluded by *specific FCC test procedures*, portable devices with output power $> 60/f_{(GHz)}$ mW shall include SAR data for equipment approval. The FCC Laboratory may be contacted if SAR is expected to be very low, especially for devices operating below 300 MHz, to determine if SAR evaluation is necessary.[5]

d) When applicable, 802.11 a/b/g devices should be tested according to the antenna diversity procedures in KDB 248227.[6] Contact the FCC Laboratory for antenna diversity test requirements, such as MIMO and beam-forming, in other product configurations.

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[1] RF exposure evaluation includes measurement or computational modeling of field strength, power density, or SAR for devices subject to MPE or SAR limits. For mobile devices that are categorically excluded from routine evaluation, simple calculations may be used to estimate the field strength or power density to determine minimal antenna-to-user separation distances.

[2] Other equipment authorization policies and procedures include items in the TCB Exclusion List (KDB 628591), Permit But Ask Procedure (PBA) (KDB 388624), Permissive Change Policies (KDB 178919), OET Bulletin 65 and Supplement C 01-01, procedures at FCC OET Measurement Techniques (www.fcc.gov/oet/ea/eameasurements.html), and in other KDB Publications (www.fcc.gov/labhelp).

[3] The *specific FCC test procedures,* identified by KDB Publication numbers, are available using links at the website (www.fcc.gov/oet/ea/eameasurements.html). SAR measurement procedures presently available from this website are those for: 3GPP/3GPP2 devices (KDB 941225); 802.11 a/b/g devices (KDB 248227); laptop computers (KDB 616217), notebook/netbookand tablet computers (Supplement to KDB 616217), and cell phones (KDB 648474) with multiple transmitters; 3 - 6 GHz devices (KDB 865664); system accuracy verification (KDB 450824).

[4] *See* footnote 3, *supra*.

[5] This provision applies to portable devices that are designed with large antenna-to-user separation distances such that the SAR is expected to be < 0.2 W/kg at the specified operating frequency and power level.

[6] *See* footnote 3, *supra*.

e) When the SAR procedures require multiple channels to be tested and the 1-g SAR for the highest output channel is less than[7]

i) 0.8 W/kg, where the transmission band corresponding to all channels is ≤ 100 MHz, testing for the other channels is not required; or

ii) 0.4 W/kg, where the transmission band corresponding to all channels is ≤ 200 MHz, testing for the other channels is not required.

f) Test reports should only include data for the test configurations that are required to demonstrate compliance to the FCC rules. Test results that are not required, but included with prior FCC confirmation, must be identified and documented in test reports as inapplicable data that has not been considered for FCC equipment certification.

g) Installation and operating instructions as required by §§ 2.1033(b)(3) and 2.1033(c)(3) are necessary for installers, integrators and end users to comply with mobile and portable transmitter exposure requirements.

2) Transmitters and modules for use in portable exposure conditions that do not require SAR evaluation for simultaneous transmission

a) Unlicensed intentional radiators and licensed devices can be approved as either a transmitter or a module for use in stand-alone portable exposure conditions that do not allow simultaneous transmission.[8,9] Based on the SAR or output power level, the following three conditions may be applied; otherwise, the provisions of item 2) c) should be considered. When SAR is evaluated using the procedures in item 2) b), additional stand-alone SAR evaluation is not required to incorporate the transmitter into final products based on procedures contained herein, or in KDB 616217 and its supplement or KDB 648474, when simultaneous transmission SAR evaluation is not required for the transmitter.[10]

i) A device may be used in portable exposure conditions with no restrictions on host platforms when either the source-based time-averaged output power is ≤ $60/f_{(GHz)}$ mW or all measured 1-g SAR are < 0.4 W/kg.[11] When SAR evaluation is required, the most conservative exposure conditions for all expected operating configurations must be tested.

ii) A device may be approved for use in multiple host platforms, each with similar family attributes, for example, PDA, laptop/notebook/netbook computers, and tablet computers, when each host platform is tested in the most conservative exposure conditions and the 1-g SAR is < 0.8 W/kg for all configurations.

iii) A device may be approved for use in a single platform when all hosts within the same platform have the same operating configurations and exposure conditions, with only minor configuration and construction differences. The most conservative exposure conditions among all host configurations within the platform must be fully tested using the procedures in item 2) b) according to the required platform test configurations, such as those in item 4); the

[7] This enables the number of frequency channels required for testing in item 6 c) to be reduced without the need for a KDB inquiry or PBA.

[8] Other equipment authorization requirements, such as limited modular approval [§ 15.212(b)] and composite system [§ 15.31(k)] may also apply.

[9] Stand-alone portable exposure conditions apply to single or multiple transmitters that do not transmit simultaneously.

[10] *See* footnote 3, *supra*.

[11] A device can be a transmitter, a module or a final product by itself.

remaining less restrictive exposure conditions and host configurations may apply [see the procedures in item 1) e)]. The 1-g SAR must be < 1.2 W/kg for all configurations.

b) The conditions of item 2) a) are established using the following SAR procedures:

i) The antenna(s) and radiating structures must be tested for each host platform and device configuration according to the minimum separation distance expected for all applicable operations.

(1) Devices that can be connected to a host through a cable must be tested with the device positioned in all applicable orientations against the flat phantom.[12]

(2) Devices without built-in mechanisms, such as a permanent housing, to provide a fixed minimum separation distance from users, must be tested with the antenna(s) and radiating structures in direct contact against the flat phantom.

(3) Devices connected to built-in, non-extendable interfaces, such as CardBus or SDIO, must be tested according to the minimum separation distance required for the host and device configurations.[13] Contact the FCC Laboratory for other interface and host device test requirements.

ii) The test configuration with the highest 1-g SAR for each device configuration, evaluated in items 2) a) i) and 2) b) i) (2), must be used to determine if additional SAR evaluation is required due to enhanced energy coupling at increased separation distances.

(1) The probe tip is positioned at the peak SAR location determined in item 2) b) ii), at a distance of 2 mm from the phantom surface. With the probe fixed at this location, the device is moved away from the phantom in 5 mm increments from the initial touching or minimum separation position. A single-point SAR (not 1-g SAR) is measured for each of these device positions until the SAR is less than 50 % of that measured at the initial device position.

(2) When the device position in item 2) b) ii) (1) with the highest point SAR is 25 % greater than that measured at the initial device position, a complete 1-g SAR evaluation is required for that configuration.

iii) Installation and operating requirements, including restrictions, for the condition(s) of item 2) a) and host platform(s) approved in the equipment authorization must be provided to OEM integrators and end users to comply with RF exposure requirements.

c) When the maximum 1-g SAR is ≥ 1.2 W/kg for devices evaluated under item 2) a), a PBA is required for TCB approval. In addition, the transmitter or module may need to be tested and approved for the operating configurations and exposure conditions of a dedicated host device. Devices that can be connected to multiple hosts by the user may need to adjust the design to meet SAR requirements.[14] An inquiry should be submitted to the FCC Laboratory to determine if other options are applicable and acceptable.

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[12] A separation distance ≤ 0.5 cm is required for USB dongle transmitters. Contact the FCC Laboratory concerning requirements for other device form factors and interfaces; see also other guidance in the attachment to KDB 447498 for USB dongle transmitters.

[13] A separation distance ≤ 1.0 cm is required for this type of interface module used in laptop computers; a separation distance ≤ 0.5 cm is required for PDA and similar platforms. The distance is measured from the module to the surface of a flat phantom.

[14] This provision applies to devices with high SAR and users can freely operate such devices in different hosts where SAR may change due to design and operating variations.

3) Transmitters and modules for use in portable exposure conditions that allow simultaneous transmission

a) Except during network hand-offs where the maximum hand-off duration is less than 30 seconds, simultaneous transmission applies when there is overlapping transmission. SAR is evaluated for simultaneous transmission using volume scan measurements.[15]

b) SAR is not required for the following simultaneous transmission conditions[16]

i) When excluded by the procedures in KDB 616217 or KDB 648474.[17]

ii) When specific requirements for simultaneous transmission SAR evaluation have not been established for the host platform or device configuration:

(1) for the antennas that are located < 5 cm from persons, where

(a) The closest antenna separation distance is ≥ 5 cm for all simultaneous transmitting antennas within the host or device; and

(b) The sum of the 1-g SAR is < 1.6 W/kg for all simultaneous transmitting antennas that require stand-alone SAR evaluation or the SAR to peak location separation ratios are < 0.3 for all simultaneous transmitting antenna pairs;[18] and

(c) The output power is $\leq 60/f_{(GHz)}$ mW for any simultaneous transmitting antenna(s) for which stand-alone SAR evaluation is not required.

(2) for the antennas that are located ≥ 5 cm from persons, contact the FCC Laboratory to determine if the simultaneous transmission SAR exclusion procedures for laptop/notebook/netbook computers in KDB 616217 and its supplement may be applied.[19]

c) The operating and installation requirements, including restrictions, must be provided for OEM integrators and end users to comply with simultaneous transmission SAR requirements.

4) SAR test positions and requirements for specific host platforms and exposure conditions

a) Antennas installed in the keyboard or base sections of laptop or convertible tablet computers are evaluated in *Laptop Mode* with the bottom of the computer in direct contact against a flat phantom and the display open to the perpendicular (90º) position.[20] The simultaneous transmission test requirements in item 3) b) ii) (1) may be applied to the keyboard section of laptop computers.

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[15] Volume scan SAR measurement requirements are described in KDB 616217 and KDB 648474.

[16] *See* Permit But Ask Procedure (KDB 388624) regarding certification requirements when simultaneous transmission SAR evaluation is required.

[17] *See* footnote 3, *supra*.

[18] SAR to peak location separation ratio is defined in KDB 648474.

[19] *See* footnote 3, *supra*.

[20] Tablet computers are constructed either with the keyboard and display in a single section ("slate" type), or in two hinged sections ("convertible" type) where the display can be folded onto the keyboard section or unfolded like a laptop computer. For testing purposes, *Laptop Mode* is defined as the operating configuration where the display is open perpendicular to and facing towards the keyboard.

b) The following procedures are applicable to tablet computers with antennas installed along the tablet edges while operating in *Tablet Mode*.[21] When the output power of an antenna is $> 60/f_{(GHz)}$ mW, SAR is required for both bottom face and edge exposure conditions.

i) Each antenna is evaluated for bottom face exposure with the base/bottom of the tablet in direct contact with a flat phantom. Convertible tablets must be tested in normal use conditions with the display folded on top of the keyboard section. The simultaneous transmission test requirements in item 3) b) ii) (1) may be applied to tablet computers in this operating mode.

ii) Antennas installed along the edges of a tablet are each evaluated with the corresponding edge in direct contact with a flat phantom. The applicable edge configurations include: (A) one fixed display orientation in either portrait or landscape configuration; (B) two fixed display orientations with one in portrait and one in landscape configurations; and (C) multiple display orientations supporting both portrait and landscape configurations.

(1) For edge configuration (A): SAR is required for each antenna located within 5 cm of the tablet edge closet to the user for the applicable display orientation. For antenna(s) located ≥ 5 cm from this edge, the test reduction and exclusion procedures for laptop computers in KDB 616217 are applied.[22]

(2) For edge configurations (B) and (C): The procedures for edge configuration (A) are applied to each antenna, for the applicable display orientations where the corresponding edge is closest to the user. For each antenna, SAR is required only for the edge with the most conservative exposure condition.

iii) For each edge positioned closest to the user, simultaneous transmission SAR evaluation is not required when the simultaneous transmitting antennas along that edge are:

(1) located < 5 cm from the edge and the sum of the stand-alone 1-g SAR is < the SAR limit for these antennas or the SAR to peak location separation ratios are < 0.3 for all antenna pairs.[23]

(2) located ≥ 5 cm from the edge and the simultaneous transmission SAR exclusion procedures for laptop computers in KDB 616217 are applicable.[24]

c) Extremity and body SAR evaluation considerations

i) PDA, UMPC (Ultra-Mobile PC), and devices with similar form factor and configurations that allow next to the ear transmissions are tested according to the handset procedures in IEEE Std 1528-2003, OET Bulletin 65 Supplement C 01-01 and the *specific FCC test procedures*.

ii) Devices that allow transmissions while worn next to the body using an accessory are tested with the device and associated accessories in all applicable orientations, at the minimum separation distance, using a flat phantom.

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[21] For testing purposes, *Tablet Mode* for a convertible tablet computer is defined as the operating configuration where the display is folded over onto the keyboard section and facing outwards. The display orientation may be switched between portrait or landscape configurations for both slate and convertible tablets, allowing one or more of the tablet edges to become closest to the user during normal use.

[22] *See* footnote 3, *supra*.

[23] *See* footnote 18, *supra*.

[24] *See* footnote 3, *supra*.

iii) Contact the FCC Laboratory to determine whether:

(1) Hand SAR is required for hand-held and hand-operated devices with output power $> 1000 \cdot [f_{(GHz)}]^{-0.5}$ mW that are designed with the hand operating closer than 5 cm from the antenna during normal use.[25]

(2) Extremity SAR is required for wrist, feet or ankle worn devices.

(3) Body SAR is required for hand-held and hand-operated or wrist, feet and ankle worn devices that operate closer than 5 cm to the body and the output power is $> 300 \cdot [f_{(GHz)}]^{-0.5}$ mW.

d) The simultaneous transmission SAR evaluation procedures for cell phones in KDB 648474 may be applied to antennas that are built-in within a PDA or UMPC.[26] Contact the FCC Laboratory for other devices having similar packaging and form factors.

5) Push-to-talk (PTT) devices[27]

a) RF exposure is evaluated with a duty factor of 50 % when the actual operating duty factor is ≤ 50 %.[28] Devices supporting higher duty factors shall be evaluated at the maximum duty factor; for example, devices supporting operator-assisted PSTN calls. Contact the FCC Laboratory when unable to test a device at the required duty factor due to hardware limitations or other reasons.

b) Portable PTT devices

i) The power thresholds and operating conditions in Table 1 are used to determine SAR test requirements for PTT radios required to comply with the general population exposure limit. When the occupational exposure limit applies, these power thresholds are increased by a factor of five (5) to determine the test requirements. SAR is required for PTT devices with maximum output power greater than these thresholds.[29] SAR evaluation is also required for separation distances smaller than those in Table 1. Contact the FCC Laboratory to determine if SAR evaluation is necessary for other frequencies or when the SAR is very low.

Table 1 - SAR Evaluation Power Thresholds for PTT devices, $f \leq 0.5$ GHz

Exposure Conditions	mW
Held to face ≥ 2.5 cm	250
Body-worn ≥ 1.5 cm	200
Body-worn ≥ 1.0 cm	150

Notes:
1. The time-averaged output power, corresponding to the required PTT duty factor, is compared with these thresholds.
2. The closest distance between the user and the device or its antenna is used to determine the power thresholds.

[25] Hand-held and hand-operated devices are inherently designed to only transmit while operated in the user's hands.

[26] *See* footnote 3, *supra*. The cellphone procedures in KDB 648474 may apply when the same types of transmitters described in the procedures are used and next to the ear, head exposure conditions, does not apply.

[27] These provisions are limited to radios with a mechanical PTT button and no other operating modes.

[28] Transmit and receive duty factors of PTT devices are generally considered to be 50 %.

[29] PTT radios should be tested according to procedures described in the "Body-Worn and Other Configurations" section of OET Bulletin 65 Supplement C 01-01 (Appendix D).

ii) Additional SAR evaluation with a SAM phantom is required for PTT devices with held-to-ear operating mode.[30] Contact the FCC Laboratory for device operating and test configurations.

6) Test reduction considerations

a) For devices operating with passive accessories, such as optional/additional batteries, body-worn or other audio accessories, that are not primary radiating elements, but can introduce SAR changes, a manufacturer may submit an inquiry to the FCC Laboratory to request guidance for test reduction prior to commencement of testing. The KDB inquiry should include at least:

i) a detailed test plan based on the SAR impact of each accessory.

ii) a detailed explanation of the features and parameters considered; for example, material, construction, separation distance and similarity, etc.

b) Devices with multiple and optional antennas do not qualify for the same test reduction intended for passive accessories. Because antennas are primary radiating elements, each antenna must be tested independently to determine the highest exposure conditions, and the highest exposure configuration tested for each antenna should be used to determine the possible test reduction for the accessories used with that antenna.

c) When the number of test frequencies or specific frequency channels are not specified in the FCC procedures or KDB publications, the following equation should be used to determine the number of required test channels to ensure sufficient frequency channels have been tested for the frequency range and transmission bandwidth used for the transmitter. A KDB inquiry is required to determine if a reduced number of channels may be used for testing and whether a PBA is required for TCB approval.

$$N_c = Round\left\{\left[100\left(f_{high} - f_{low}\right)/f_c\right]^{0.5} \times \left(f_c/100\right)^{0.2}\right\};$$

where N_c is the number of test channels, f_{high} and f_{low} are the highest and lowest frequencies within the transmission band, f_c is the mid-band frequency, and frequencies are in MHz.

7) Stand-alone mobile devices[31]

a) When routine evaluation is required, MPE measurement or computational modeling is used to show compliance for § 2.1091(c).

b) For transmitters that are categorically excluded by § 2.1091(c), a separation distance smaller than that provided by conservative MPE estimates (simple calculations) may be used when justified according to MPE measurement or computational modeling results, provided the smaller distance is applicable for the operation of the transmitter and its antenna(s).

c) A minimum separation distance of 20 cm is required and must be supported by the operating and installation configurations of the transmitter and its antenna(s).

[30] See footnote 27, *supra*.

[31] A stand-alone mobile device may contain a single transmitter, or multiple transmitters that do not transmit simultaneously.

8) Transmitters and modules for use in mobile exposure conditions that allow simultaneous transmission

a) Transmitters and modules certified for mobile or portable exposure conditions and categorically excluded by § 2.1091(c) can be incorporated in mobile host devices without further testing or certification when:

i) The closest separation among all simultaneous transmitting antennas is ≥ 20 cm;[32] or

ii) The antenna separation distance and MPE compliance boundary requirements that enable all simultaneous transmitting antennas incorporated within the host to comply with MPE limits are specified in the application filing of at least one of the certified transmitters incorporated in the host device.[33] In addition, when transmitters certified for portable use are incorporated in a mobile host device the antenna(s) must be ≥ 5 cm from all other simultaneous transmitting antennas.

b) All antennas in the final product must be at least 20 cm from users and nearby persons.

9) Use of occupational and general population limits and exposure conditions

a) Occupational exposure limits generally do not apply to consumer devices and radio services supporting public networks and unlicensed frequencies.

b) RF exposure training instructions and labeling are required for users to comply with the occupational exposure requirements. Information must be included in the equipment authorization application to ensure that occupational exposure limits are only applied to "work-related" conditions, where users must be "fully aware of" and be able to "exercise control over" their exposure to qualify for the higher exposure limits.

c) Occupational training and labeling are not required for devices that comply with the general population exposure limits.

[32] The term "antennas" includes all antennas and radiating structures that may influence exposure compliance.

[33] Each transmitter must comply with the operating requirements and restrictions for all transmitters incorporated within the host. When routine evaluation is not required, MPE compliance requirements for simultaneous transmission can often be estimated for certain generic or specific configurations according to antenna output power, antenna-to-antenna and antenna-to-user separation distances to establish the required separation distances and compliance boundary for the specified exposure conditions. A compliance boundary is the perimeter that provides the required user separation distances in all directions surrounding the antennas where MPE limits are met for simultaneous transmission.

Date	Change Notices:
07/27/2008	447498 D01 Mobile Portable RF Exposure v03r01 has been changed to a new revision under the same Version: 447498 D01 Mobile Portable RF Exposure v03r02 Page 4: 3 (b) (ii) (1) (b) "SAR-to-antenna-separation ratios" changed to "SAR to peak location separation ratios" for clarification. Page 4: Footnote 17 "SAR-to-antenna-separation ratio" changed to "SAR to peak location separation ratio" for clarification. Page 5: 4 (b) (iii) (1) "SAR-to-antenna-separation ratios" changed to "SAR to peak location separation ratios" for clarification.
01/22/2009	447498 D01 Mobile Portable RF Exposure v03r02 has been changed to a new revision under the same Version: 447498 D01 Mobile Portable RF Exposure v03r03 Page 3 Note [13] : This provision applies to devices with high SAR and users can freely operate such devices in different hosts where SAR may change due to design and operating variations." **has been changed to** "*This provision applies to devices with high SAR and users can freely operate such devices in different hosts where SAR may change due to design and operating variations.* ***These devices fall under the Section 2(e) in the TCB exclusion list.*****"**
11/13/2009	447498 D01 Mobile Portable RF Exposure v03r03 has been changed to a new Version: 447498 D01 Mobile Portable RF Exposure v04 1) Several places are amended to cross-reference not only KDB 616217 but also the "netbook" supplement; i.e., the following places: footnote 3; 1) b); 2) a); 2) a) ii); 3) b) ii) (2) 2) Introductory paragraph third sentence changed from "thresholds in this document are applied …" to "thresholds in this document are applied for conducted power …" 3) Footnote 2 amended to include: "Permit But Ask Procedure (PBA) (KDB 388624), Permissive Change Policies (KDB 178919)" 4) Item 1) c) changed from "devices below" to "devices operating below" 5) New footnote 7 added at item 1) e); subsequent foonotes re-numbering accordingly 6) At item 1) f) changed from "but included," to "but included with prior FCC confirmation," 7) The re-numbered footnote 12 amended to include "see also other guidance in the attachment to KDB 447498 for USB dongle transmitters" 8) At item 2) b) ii), changed from "for each host platform and device configuration, evaluated in items 2) a) and 2) b)" to "for each device configuration, evaluated in items 2) a) i) and 2) b) i) (2)" 9) Item 2) b) ii) (1) changed from "distance of one half the probe tip diameter" to "distance of 2 mm" 10) Item 2) b) ii) (1) changed from "A single point SAR is measured" to "A single-point SAR (not 1-g SAR) is measured" 11) Item 2) b) ii) (2) is changed from "highest point SAR is > 25% of that measured" to "highest point SAR is 25 % greater than that measured" 12) Item 2) c) changed from "When the maximum 1-g SAR is ≥ 1.2 W/kg, the transmitter or module …" to "When the maximum 1-g SAR is ≥ 1.2 W/kg for devices evaluated under item 2) a), a PBA is required for TCB approval. In addition, the transmitter or module …" 13) Item 2) c) amended to include "An inquiry should be submitted to the FCC Laboratory to determine if other options are applicable and acceptable." 14) Re-numbered footnote 16 changed to cross-reference PBA (KDB 388624) rather than TCB Excl. List (KDB 628591) 15) At item 4) b) ii) (2), changed from "edge configuration (a)" to "edge configuration (A)" 16) New item added, i.e., "6) Test reduction considerations"; subsequent items are re-numbered as follows: "6) Stand-alone mobile devices" changed to "7) Stand-alone mobile devices" "7) Transmitters and modules for use in mobile …" changed to "8) Transmitters and modules for use in mobile …" "8) Use of occupational and …" changed to "9) Use of occupational and …" 17) The re-numbered item "8) Transmitters and modules for use in mobile …" is changed by moving the last sentence of 8) a) ii) to be 8) b)